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A NEW APPROACH FOR STUDYING THE EXPANSION OF DETONATION PRODUCTS

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DISCLAIMER

A NEW APPROACH FOR STUDYING THE EXPANSION OF DETONATION PRODUCTS

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Single crystal 100 LiF has well known mechanical and optical properties. Consequently, it has been used for many years as a window when studying inert materials via the velocimeter technique. Because of its close impedance match to detonating HE, we have used this technique to probe the expansion of detonation products. Our data on LX14 clearly show the Von Neumann spike as well as many other structures not yet identified. The best estimate for the CJ pressure is 35.3 GPa.

INTRODUCTION

An ideal material to use in studying the equation of state of HE would be one that is optically transparent and has the same acoustic impedance as detonating HE. By measuring the HE/material interface velocity we would, in effect, be measuring the material velocity of the HE along the CJ adiabat. This kind of experiment has an advantage over the more common metal plate acceleration tests because the former is directly related to the CJ adiabat itself, while the latter is only a consequence of the adiabatic expansion.

Single-crystal LiF is almost the ideal material; its acoustic impedance is about 10% higher than detonating LX14. Furthermore, LiF has been used in shock-wave studies of inert materials for many years and its mechanical and optical properties are well known [1].

In this paper, we will show the results from two preliminary experiments using this technique.

PLAN OF THE EXPERIMENT

The basic experimental configuration is shown in Fig. 1. The HE charge for the first experiment (9523) had a machined surface. It was bonded to the aluminized LiF with ordinary vacuum grease using a lead brick to press the two together for about 4 hours. The mirror separation in the Fabry Perot velocimeter was 7.01mm implying a time resolution of ~ 2.3 ns. The laser wave length was 5,145A and the Imacon camera was running at 20 ns/mm.

The second experiment (9541) had a pressed surface and the bonding time was increased to about 12 hours. The mirror separation was 14.015mm and the camera was again running at 20 ns/mm.

The total kinetic energy in the mylar initiator was only about 1/3% of the total energy of the system. Numerical simulations of the experment showed that the initiator had a negligible effect on the results.

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DISCUSSION OF THE DATA

Fig. 2 shows the results of these two preliminary experiments. Note the surpassed zero. The reproducibility is good; the differences are only 1-2%. While there is a lot of structure, three points in particular seem to stand out. The first is a sharp spike which presumably can be identified as the Von Neumann spike. Following this by about 10-20 ns is a small increase in velocity. Finally, there is a ~ 75 ns long plateau which ends about 150 ns after the shock arrival.

The small second bump could merely be a reflection of the complicated hydrodynamics of the Von Neumann spike interacting with the LiF, or it could be a sign of late-time chemical reactions. There is also a question about what point should be identified as the CJ point. Is it at the base of the spike or perhaps at the end of the plateau? It depends on what size we expect the reaction zone to be. The best estimate of CJ pressure, using a JWL form to fit the data, is 35.3 GPa.

More work remains to be done. The LiF crystals were 5mm thick which permits only 500 ns of observation time. This is only enough to drop the pressure from CJ to about 26 GPa. 25mm thick crystals will let us go to about 10 GPa which gives good overlap with cylinder expansion data. In the next experiments we will use highly polished HE surfaces and mineral oil to fill interface gaps. We will also study the effect of varying charges length as well as examining other high explosives such as PBX 9404 and TATB.

REFERENCES

1. J. L. Wise, to be published in the proceedings of the Fourth APS Topical Conference on Shock Waves in Condensed Matter (Spokane WA, July 22-25, 1985).

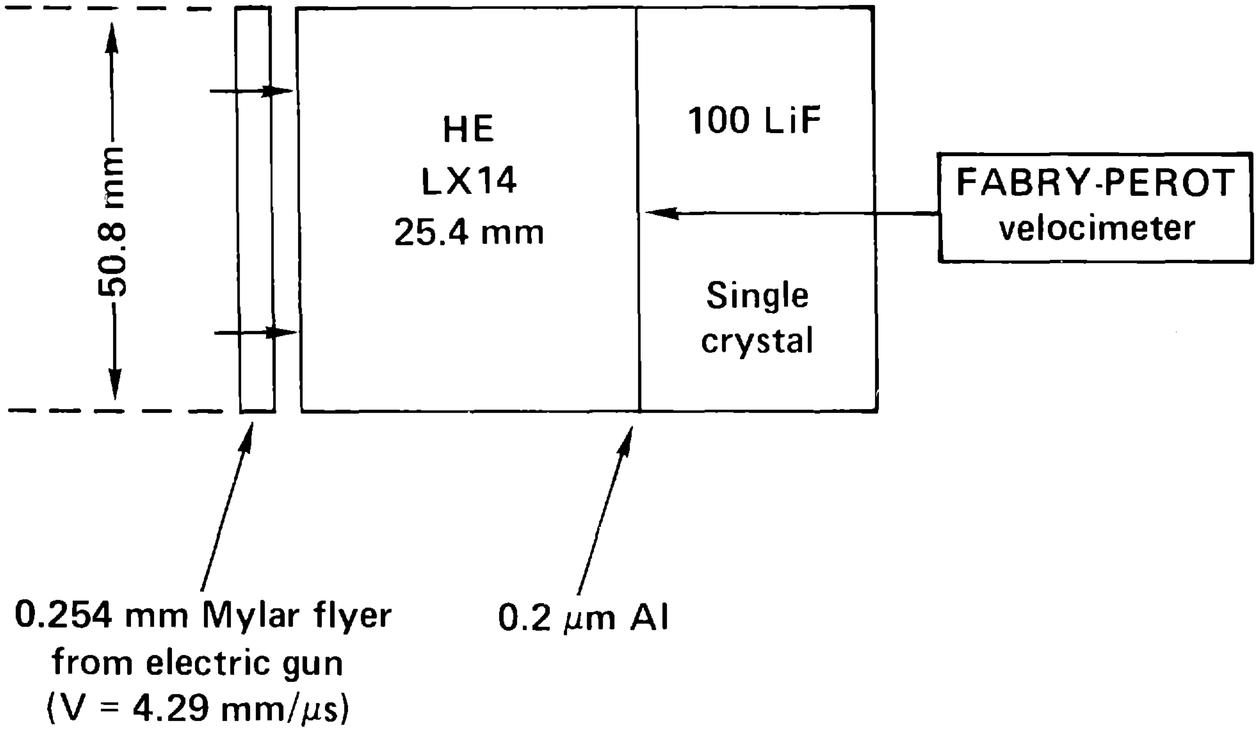

Figure 1. Basic experimental configuration

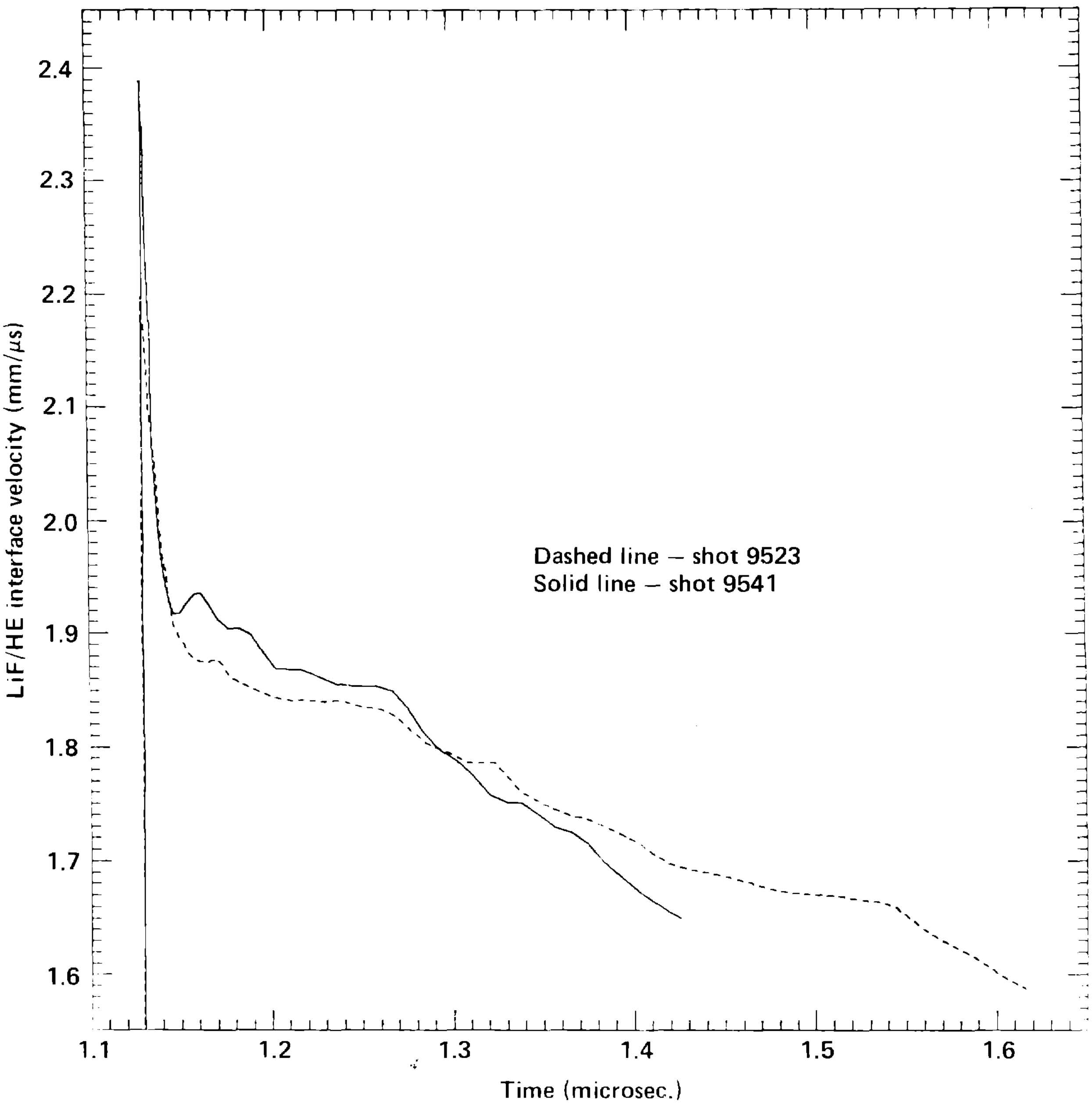

Figure 2. LiF/HE interface velocity vs. time for two preliminary experiments